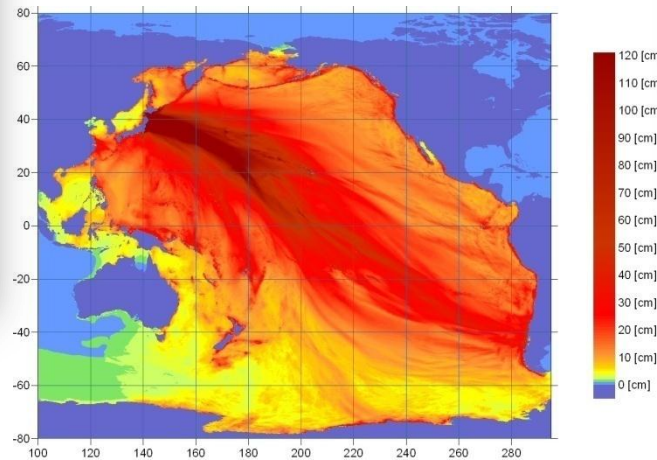


# March 11, 2011 Tohoku Tsunami

## Maritime Impacts and Future Improvements



Port of Sendai, Japan



2011 Japan



Morro Bay Harbor, California

Rick Wilson, California Geological Survey



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# Port of Noda, Japan





# Port of Noda, Japan



# Comparison – Three recent tsunamis for California

## Example: Santa Cruz Harbor

	Sept. 29, 2009	Feb. 27, 2010	March 11, 2011
Earthquake magnitude/location	M8.1 Tonga/Samoa	M8.8 Maule, Chile	M9.0 Tohoku, Japan
Warning Center Alert Level for California	Advisory	Advisory	Warning, then Advisory
Approximate travel time of tsunami to Santa Cruz Co.	11 hours	13 hours	10 hours
Approximate peak wave amplitude in Santa Cruz Co. (Andy Ritchie, USGS)	1-2 feet	2-3 feet	+5-6 feet
Approximate duration of strong wave action in parts of California	~ 4 hours	~ 8 hours	+ 24 hours
Effects/Damage in State	<ul style="list-style-type: none"> <li>- Minor to moderate currents in harbors</li> <li>- \$0 in damages</li> </ul>	<ul style="list-style-type: none"> <li>- 12 harbors damaged</li> <li>- \$3M in damage</li> </ul>	<ul style="list-style-type: none"> <li>- +24 harbors damaged</li> <li>- +\$50M in damage</li> <li>- One death</li> </ul>
Effects/Damage in Santa Cruz Co.	<ul style="list-style-type: none"> <li>- Moderate currents</li> <li>- \$0 in damages</li> </ul>	<ul style="list-style-type: none"> <li>- Mod to Strong currents</li> <li>- Tens of thousands</li> </ul>	<ul style="list-style-type: none"> <li>- Strong to very strong currents</li> <li>- +\$28M in damage</li> </ul>

**Fortunate: Last two events occurred at low tide.**



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# 2011 Tohoku Tsunami in Northern California

- **Warning, then Advisory**
  - Largest tidal fluctuations
- **Tsunami activity lasted for extended time**
  - 24 hrs of potential dangerous conditions
- **Extensive damage**
  - **Crescent City**
    - Boat evacuation success
    - +60 boats sunk/damaged
    - 9 month delays in sediment removal
  - **Klamath – one fatality**
  - **Noyo River marinas**



*Alan Mello, boat owner, discussing evacuation of Amanda B during tsunami*



*Noyo River (Fort Bragg)*



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# 2011 Tohoku Tsunami in Central California

- **Warning, then Advisory**
- **Damage to harbors**
  - SF Bay Area
    - Sausalito
    - Berkeley
  - **Santa Cruz – significant**
    - \$28M in damage
    - All docks damaged
  - Moss Landing (\$1M – Fed Disaster)
  - Morro Bay (\$500k)



*Sausalito*



*Santa Cruz, upper harbor*



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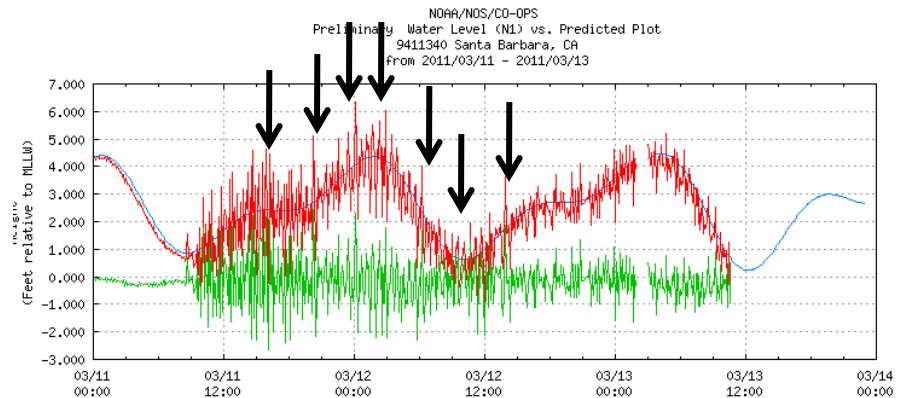
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# 2011 Tohoku Tsunami in Southern California

- **Advisory, south of Point Concepcion**
- **Damage to harbors**
  - Santa Barbara
  - Ventura
  - Redondo Beach
  - Ports of LA/LB
  - Two Harbors (Catalina)
  - Ocean Beach rescue
  - Mission Bay
  - Shelter Island – South
- **Extended tsunami activity (peaks 2-3hrs)**



**Shelter Island, South Harbor Police Dock**



**Santa Barbara tide gauge – 2-3hr peaks**



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# Maritime issues from March 11, 2011 event

- Keeping people away from boats and water during tsunami
- Notification issues
- If/When/Where to evacuate boats?
- Educate boat owners about tsunami hazards
- Minimize harbor damage
- Response fatigue
- Ongoing recovery
- Improving resiliency



*Boats sunk and docks damaged; recovery efforts in Crescent City Harbor*



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# Maritime Safety Products

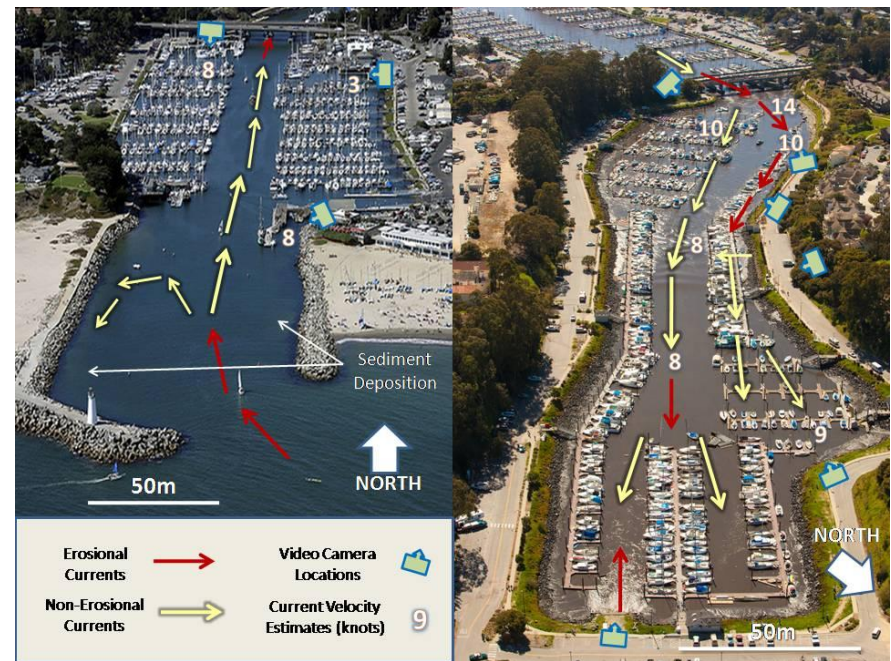
## Analysis of 2010 and 2011 tsunamis in pilot study harbors

Crescent City, Santa Cruz, Ventura, Ports of LA/Long Beach,  
and Shelter Island (San Diego Bay)

Video and other analyses of currents, sediment scour/deposition, areas of damage, safe areas



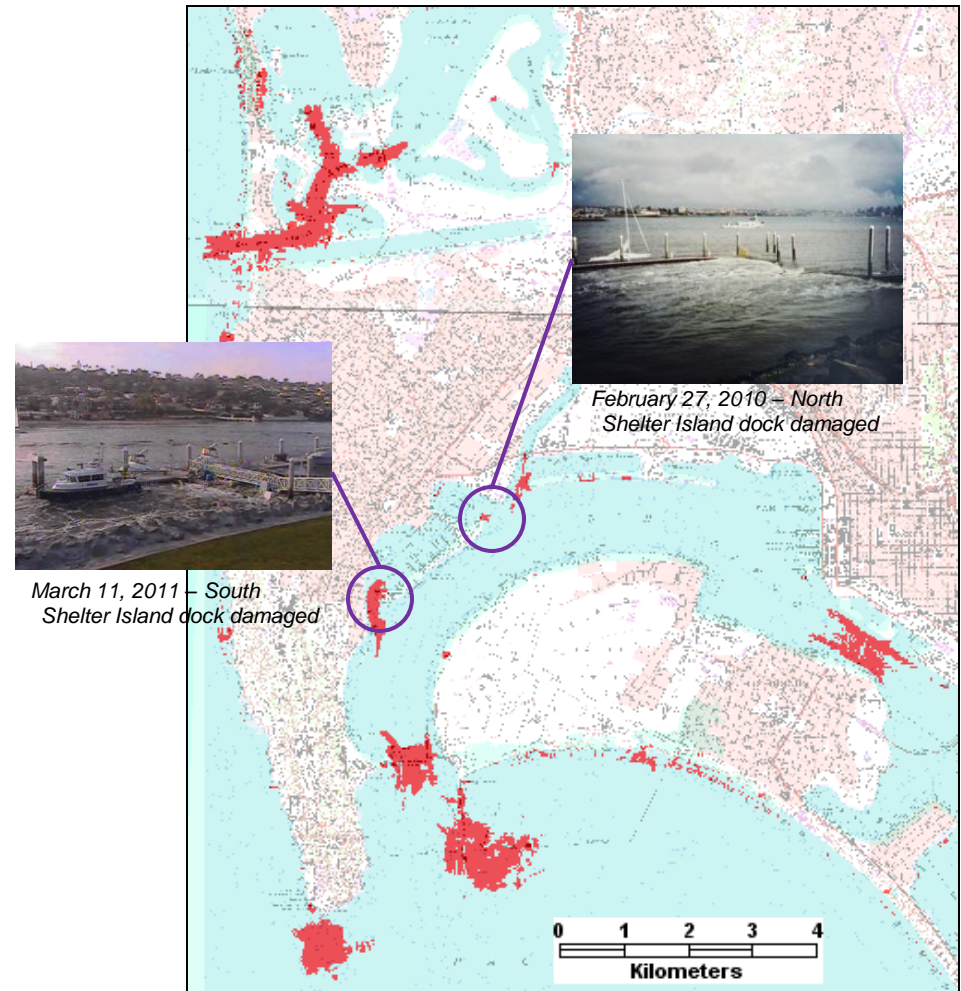
*2011 tsunami in Crescent City*



*2011 tsunami in Santa Cruz*

# In-Harbor Tsunami Hazard Maps

- Multiple scenarios that identify areas of strong currents, eddies, and other tsunami hazards
- Will assist harbors with:
  - Maritime evacuation planning
  - Emergency response planning for harbor patrol
  - Future infrastructure planning
- FEMA RISK-map products
- Guidance for harbor masters, harbor patrol, and boaters will be developed



2011 – CGS/CalEMA/USC

Potentially damaging tsunami currents (in red)  
for San Diego area from M9.2 earthquake on  
eastern Aleutian Islands subduction zone

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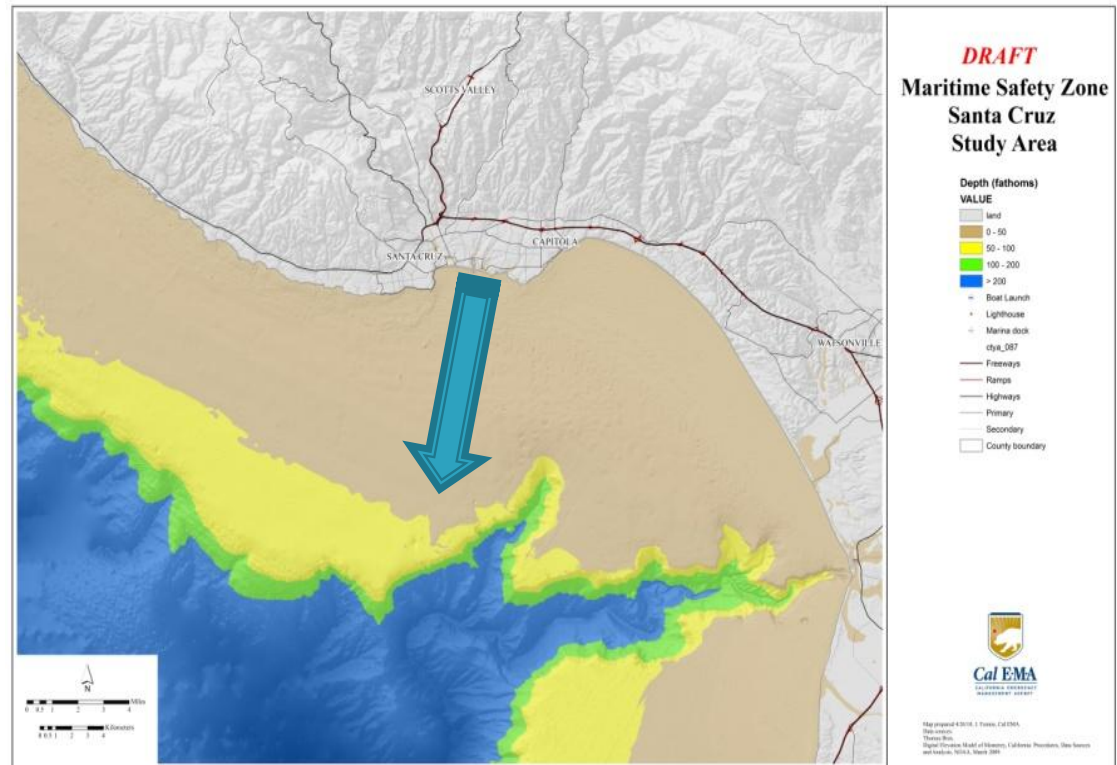


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# Offshore Safety Zones

- **Working with NOAA, West Coast states, and Canada**
- **“Rule of thumb” for safety is 100 fathoms**
- **Zones will be harbor/boat specific and included in navigational charts**
- **Guidance for harbor masters on Advisory and Warning-level events**



*Draft maritime evacuation map for Santa Cruz Harbor*

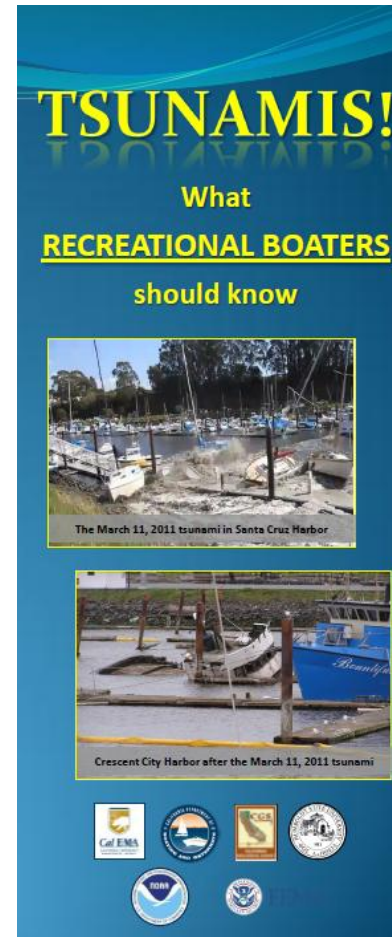


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# Policy/Guidance/Outreach

- Several types of boating communities (different size ships and levels of experience):
  - Recreational
  - Commercial/Fishing
  - Large transport/cruise ships/military
- Policy work group forming
  - Planning issues
  - Recovery issues
- National guidance for harbor masters and boaters needed
- Brochures for boaters (draft)

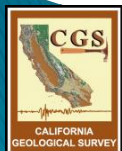


## Should you take your boat OFFSHORE?

The answer to this question depends on two things: 1) the size of the tsunami, and 2) the experience of the boater.

For most harbors in California, it is safer to keep your boat docked during a tsunami because most tsunamis are relatively small. On the rare occasion where a large tsunami is expected and the boat captain is an experienced mariner, the boat owner may consider taking their boat offshore to safety if there is sufficient time to do so. Ultimately, your harbor master or port captain may provide the best advice.

If you are thinking about taking your boat offshore before a tsunami arrives, be prepared to stay offshore for 24 hours. DO NOT attempt to leave or return to the harbor while hazardous tsunami conditions exist; you will put yourself and others helping you at risk to injury (picture below shows boat struggling to leave Crescent City Harbor during the March 11, 2011 tsunami).



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# Future Work – National Perspective

- National guidance on tsunami evacuation planning
  - NTHMP MMS, MES, WCS
  - Others: Coast Guard, State boating
- National guidance/strategies on tsunami hazard mitigation planning
  - Include recovery and resiliency
  - MMS and MES
- Re-authorization of Tsunami Warning and Education Act
  - Long-term planning and funding for States to implement guidance and strategies



San Diego Bay North area (above) and infrastructure (below)



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